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THE TELEOLOGY OF INORGANIC NATURE.[1]

THE study of adaptation, of which Lamarck is the great originator, has not yet won for itself a secure scientific foundation nor led to clear and unequivocal interpretations of nature. Although the facts which this study presents are both universal and important, biologists have neither agreed upon their place in the theory of evolution nor discovered any principle by which they may be even unified.

This failure of our modern science is not hard to understand, and may farily be attributed, in part at least, to the lack of a systematic study of adaptability, which at bottom is a physical and chemical problem, uncomplicated by the riddle of life. For beneath all the organic structures and functions are the molecules and their activities. These it is which have been moulded by the process of evolution, and these no less have formed the environment.

I beg the reader to bear this in mind and constantly to remember one simple question: What are the physical and chemical origins of diversity among inorganic and organic things, and how shall the adaptability of matter and energy be described? He may then find his way through the difficulties which philosophical and biological thought have accumulated around a problem that in its most fundamental aspects belongs only to physical science.

The scientific examination of the properties and activities of the three elements hydrogen, carbon, and oxygen and of their compounds water and carbonic acid, as it was recently presented in *The Fitness of the Environment*,[2] may serve as an aid to investigate the problem of adaptability. For it is evident that diversity in nature must especially depend upon the existence and availability of suitable structural materials in the necessary profusion, variety and stability; on the existence of conditions which shall preserve the structures; on wealth of forces which shall activate them. Such specifications, like those of an architect or engineer, concern the properties of matter and energy rather than the laws of nature.

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[1] The argument which is presented in the following pages has benefited at every stage of its development by Professor Royce's criticisms and by successive discussions in his Seminary of Logic. I dedicate it to him with pleasure and gratitude.

[2] New York, The Macmillan Co., 1913.

The properties of the three elements meet most of these specifications. They lead to the presence of water and carbon dioxide in the atmosphere, and to the meteorological cycle. This cycle regulates the temperature of the globe more perfectly than it could be regulated by any other substance. It produces an almost constant temperature in the ocean, as well as constancy of composition and of alkalinity. It mobilizes all over the earth great quantities of all the elements; it deposits them in great variety and inexhaustible profusion in the ocean; it comminutes and disperses all varieties of insoluble minerals, thereby diversifying the land; it causes water to penetrate and to remain in nearly all localities. And all of these processes are more perfect or more extensive than they could be if a large number of the different properties of water were not what they are. Thereby the greatest possible variety and quantity of structural materials are accumulated. Meanwhile the conditions which make for durability of structures are insured.

Other similar results depend upon the chemical properties of the three elements. These properties lead to an even greater variety of chemical combinations and chemical reactions, to an unequalled diversity of properties in their products, and to qualitatively and quantitatively important transformations of energy.

Out of all these substances, inorganic and organic alike, the properties of water and of other substances here in question make possible the construction of an almost infinite diversity of physico-chemical systems. And, as Willard Gibbs has shown, the world of physical science is made up of systems and nothing else. Natural systems may vary almost indefinitely in the number and variety of their phases and components, in concentrations, and in configurations. They may be so constituted as to produce the most varied forms of activity. Like their components, they may manifest the greatest variety of properties and their forms include all the possible forms of life and of the mineral kingdom.

These and many other things depend upon the properties of hydrogen, carbon, and oxygen. They make up, I cannot doubt, the most remarkable group of causes of the teleological appearance of nature. Yet it must not be forgotten that they only coöperate in the process of evolution, and that many other causes are just as necessary to the results. Not only are the laws of nature concerned, but also the characteristics of the solar system, many special features of the earth itself, and especially the origin of life. Without this mysterious event the process of evolution must have remained in a far simpler condition. But more conspicuously than the other factors in the evolutionary process these fundamental properties of matter permit in a very strict scientific sense freedom of development. This freedom is, figuratively speaking, merely the freedom of 'trial and error.' It makes possible the occurrence of a great variety of trials and of a large proportion of successes. I need hardly say that we arrive at the conception of this kind of freedom only by neglecting the causes which determine the trials—in this case the general laws, the rotation of the earth, the distance of the sun, and many others. But this is equivalent to the remark that we are investigating one particular aspect of a complex problem, meanwhile following the invariable method of science.

The nature of the properties of the three elements which thus coöperate to bring these conditions to pass must now be examined. All properties, with the exception of a few which cannot at present be recognized as bearing upon the general characteristics of systems, are concerned. Each of these properties is almost or quite unique, either because it has a maximum or a minimum value or nearly so, among all known substances, or because it involves a unique relationship or an anomaly. No other element or group of elements possesses properties which on any account can be compared with these. All are deficient at many points, both qualitatively and quantitatively. And since the whole analysis is founded upon the characteristics of systems, and therefore upon concepts which specify nothing about the properties of the different kinds of matter, it is unnecessary to examine the possibility of the existence of other groups of properties otherwise unique.

Thus we reach the conclusion that the properties of hydrogen, carbon, and oxygen make up a unique ensemble of properties, each one of which is itself unique. This ensemble of properties is of the highest importance in the evolutionary process, for it is that which makes diversity possible; and diversity, as Spencer declares, is radically necessary to evolution. In short, there is here involved an order in the properties of the elements.

This new order is, so to speak, hidden, when one considers the properties of matter abstractly and statically. It becomes evident only when time is taken into consideration. It has a dynamical significance, and relates to evolution. It is associated with the periodic system of the elements in somewhat the same way that the functional order is related to the structural order in biology. Hence it is not independent of the other order, but may be said to lie masked within it.

This is no novel experience, that the consideration of phenomena in time should lead to new points of view. From Galileo's inclined plane and pendulum to the times of Darwin and modern physical chemistry, the progress of dynamics has steadily modified our outlook on nature. In truth, it might almost have been said *a priori* that a new order must be revealed by a study of the properties of matter in relation to evolution.

This order may be described abstractly as follows: The properties of matter are not evenly distributed among the elements, nor in such manner as can be explained by the laws of chance, nor are they altogether distributed in the manner which the periodic system describes. If the extremes be considered, all the physical and chemical properties are distributed with the very greatest unevenness, so that the extremes are concentrated upon a few elements, notably hydrogen, oxygen, and carbon. As a result of this fact there arise certain peculiarities of the cosmic process which could not otherwise occur.

The characteristics which make up this unique ensemble include the greater number of characteristics, and especially the most important and the most conspicuous physical and chemical properties. This order has for cosmic and organic evolution extremely important results—maximum stability of physico-chemical conditions and maximum complexity in the physico-chemical make-up of the surface of our planet; further, the possibility of maximum number, variety, complexity, durability and activity of physico-chemical systems in such an environment.

The unique ensemble of properties of water, carbonic acid and the three elements constitutes among the properties of matter the fittest ensemble of characteristics for durable mechanism. No other environment, that is to say no environment other than the surface of a planet upon which water and carbonic acid are the primary constituents, could so highly favor the widest range of durability and activity in the widest range of material systems —in systems varying with respect to phases, to components, and to concentrations. This environment is indeed the *fittest.* It has a claim to the use of the superlative based upon quantitative measurement and exhaustive treatment, which is altogether lacking in the case of the fitness of the organism. For the organism, so we fondly hope, is ever becoming more fit, and the law of evolution is the survival of the fitter.

Yet it is only for mechanism in general, and not for any special form of mechanism, whether life as we know it, or a steam engine, that this environment is fittest. The ocean, for example, fits mechanism in general; and, if you will, it fits the whale and the plankton diatom, though not man or a butterfly. But, of course, as everybody has known since 1859, it is really the whale and the diatom which fit the ocean. And this leads to a biological conclusion.

Just because life must manifest itself in and through mechanism, just because, being in this world, it must inhabit a more or less durable, more or less active physico-chemical system of more or less complexity in its phases, components and concentrations, it is conditioned. The inorganic, such as it is, imposes certain conditions upon the organic. Accordingly, we may say that the special characteristics of the inorganic are the fittest for those general characteristics of the organic which the general characteristics of the inorganic impose upon the organic. This is the one side of reciprocal biological fitness. The other side may be similarly stated: Through adaptation the special characteristics of the organic come to fit the special characteristics of a particular environment, to fit, not any planet, but a little corner of the earth.

This is a most imperfect characterization of the dynamic order in the properties of the elements, for it involves only three among more than eighty substances. More serious, perhaps, is the difficulty of reducing the statement to a methodical form. It will be well, therefore, to take it as it stands. But the ensemble of characteristics of the three elements cannot therefore be dismissed. We have to note that the connection of the properties of these elements is not to be disregarded on the ground that it is an affair of the reflective judgment, for that consideration would also lead to the rejection of the connection of properties revealed in the periodic classification of the elements. Nor can we look upon it as in any sense the work of chance.

"There is, in fact, exceedingly little ground for hope that any single explanation of these coincidences can arise from current hypotheses and laws. But if to the coincidence of the unique properties of water we add that of the chemical properties of the three elements, a problem results under which the science of today must surely break down. If these taken as a whole are ever to be understood, it will be in the future, when research has penetrated far deeper into the riddle of the properties of matter. Nevertheless an explanation cognate with known laws is conceivable, and in the light of experience it would be folly to think it impossible or even improbable."[1]

Yet such an explanation, once attained, could little avail. For a further and more difficult problem remains. How does it come about that each and all of these many unique properties should be favorable to the process of evolution? Existing knowledge provides no clue to an answer of this question. For there seems to be here no possibility of any interaction like that involved in the production of dynamic equilibrium or in natural selection. And yet the connection between the properties of the three elements, almost infinitely improbable as the result of chance, can be regarded, is in truth only fully intelligible even when mechanistically explained, as a preparation for the evolutionary process. This ensemble is the condition of the production of many systems from few, and any other sensibly different distribution of the properties among the elements, almost infinitely numerous though such conceivable distributions may be, would very greatly restrict the possibilities of the multiplication of systems. In other words, the possibility is negligible that conditions equally favorable to the production of diversity in the course of evolution should arise without cause. But we are ignorant of the existence of any cause except the mind which can thus produce results that are fully intelligible only in their relation to later events. Nevertheless we can on no account, unless we are to abandon that principle of probability which is the basis of every scientific induction, deny this connection between the properties of matter and the diversity of evolution. For the connection is fully obvious and the result is reached by a scientific demonstration.

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[1] *The Fitness of the Environment*, pp. 277, 278.

This conclusion is so important that I will try to state the argument in its simplest form. The process of evolution consists in the increase of diversity of systems and their activities, in the multiplication of physical occurrences, or briefly in the production of much from little. Other things being equal, there is maximum freedom for such evolution on account of a certain unique arrangement of unique properties of matter. A change in any one of these properties would greatly diminish the freedom. The chance that this unique ensemble of properties should occur by accident is almost infinitely small. The chance that each of the unit properties of this arrangement by itself and in coöperation with the others should accidentally contribute to this freedom a maximum increment is also almost infinitely small. Therefore there is a causal connection between the properties of the elements and the freedom of evolution. But the properties of the universal elements antedate or are logically prior to those restricted aspects of evolution with which we are concerned. Hence we are obliged to regard the properties as in some intelligible sense a preparation for the process of planetary evolution.

For we cannot imagine an interaction between the properties of hydrogen, carbon and oxygen and any process of planetary evolution or any similar process by which the properties of the elements should have been modified throughout the universe. Therefore the properties of the elements must for the present be regarded as possessing a teleological character.

It will perhaps be objected to this argument that the cause of the peculiar properties of the three elements is conceivably a simple one, such as the properties of the electron. This is perfectly true but quite beside the point. For, whether simple or complex in origin, the teleological connection—the logical relation of the properties of the three elements to the characteristics of systems—is complex. This complex connection is almost infinitely improbable as a chance occurrence. But the properties of electrons do not produce logical connections of this kind any more than they produce the logical connections of the multiplication table. Only adaptation is known to produce such results.

This is the one positive scientific conclusion which I have to contribute to the teleological problem. It must not be forgotten that it concerns but a single characteristic of the teleological appearance of nature. The question of the interplay of nature's laws is left just where we found it. And the accidental advantages which our earth possesses when compared with the other planets of the solar system, or with planets as they may be abstractly conceived are not even touched upon. Yet some of the very most remarkable conditions which lead to the diversification of the products of evolution are here involved. We have, however, to bear in mind certain of the general characteristics of all planets as they tend to appear through the influence of the properties of matter. And if the analysis has not been carried to a further stage, it is because we can see the possibility of almost infinite diversity in the properties of particular planets, while the universe seems to possess but a single system of chemical elements.

The result of our analysis is therefore nothing but an example or specimen of the scientific analysis of the order of nature. In that it is scientific it possesses two characteristics which are important to note. First it leaves the chain of mechanical determination completely unmodified. We need take no account whatever of such logical relations of things, just as we may disregard the logical relations of the periodic system, in studying any of the phenomena or groups of phenomena in nature. Secondly, like all scientific conclusions, its validity depends upon the principle of probability.[1]

The scientific value of this induction of the dynamic order in the properties of the elements must depend upon its utility as a means to the comprehension of diversity and stability in the products of evolution. But there is a further philosophical aspect of the conclusion which cannot be altogether disregarded.

In arriving at the scientific conclusion we have reached a position from which one aspect of the teleological configuration of nature can be clearly perceived and closely scrutinized. It is now evident that the diversity of the world largely depends upon a specific group of characteristics of the elements.

In order to describe the course of all natural phenomena as they have actually occurred, it is, however, quite unnecessary to understand or to take account of the peculiar relations which we have discovered to exist between these properties and the characteristics of systems. But, indeed, if we are merely to describe phenomena as they occur, it is not even necessary to take account of the law of gravitation. When, however, the more interesting task of explaining, or if this term be unacceptable, of generalizing the description, is seriously taken up, the employment of laws, which depend upon our perceptions or judgments of the relations between things, becomes necessary. The development of modern science has provided us with a considerable number of such laws, of which the most conspicuous besides Newton's law are the law of the conservation of mass, the law of the conservation of energy and the law of the degradation of energy. Such laws enable us to imagine the conditions under which all phenomena may be assumed to take place, in this manner to classify events which are widely separated in time and space, and thus gradually to approach more nearly to a conception of the world in which the infinite diversity of phenomena gives place to a very large number of possible phenomena. In establishing such a classification Newton's law and certain others have been of inestimable service; not so the most general laws like those of conservation and the second law of thermodynamics. These are too general to be always of value for this purpose, in that they are conditions of all phenomena. They have therefore often been of little use in this respect, except through their influence to make scientific thought more exact and more successfully analytical.

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[1] Cf. Newton's fourth rule of reasoning in philosophy, in which the element of probability in every induction is clearly suggested.

Another function of scientific laws has been to bring about the synthesis of the several sciences. With their help these have become highly organized bodies of knowledge which sometimes present purely mathematical exhaustiveness, rigorousness, and elegance in the treatment of problems and in some instances successful prediction of unknown facts. This is the rôle for which the general laws are best fitted. A small number of them often suffice for the systematic development of large departments of science and for the deduction of many secondary principles and large numbers of facts. Newton's *Principia* is the classical example of this process, but it is now generally admitted that for this purpose the laws of thermodynamics surpass even the fundamental postulates of Newton's mathematical analysis.

In the course of such developments it has been found necessary to employ other concepts than laws. The phenomena of nature are never simple, and rarely approach near enough to simplicity to serve as crucial experiments. The case of the solar system, as recognized and employed by Newton, is the one great example of a sufficiently isolated natural experiment. But even in the laboratory the man of science must always content himself with an imperfect elimination of disturbing factors. As a result of this difficulty the purely abstract ideas of line, mass, system, and many others have found their place in scientific thought. Thus all abstract scientific thought moves in an ideal world which never corresponds exactly with reality, but which may be made to approximate to reality within any desired limits. Such are the more important functions of the abstract principles and concepts of science which here concern us.

It has been indicated above how the concept of system may be employed in the methodical description of the general characteristics of evolution. And the one existing systematic attempt to give a full description of this process, as it appears in Spencer's *Synthetic Philosophy*, is guided by a vague and inaccurate anticipation of this idea. Moreover, we can now see that a recognition of the peculiarities of hydrogen, carbon, and oxygen is a necessary further means to the explanation of the process. For these peculiarities are a significant condition of every stage, and without them the most general characteristics of nature could never have arisen. This generalization is therefore a typical instrument of scientific thought, in that it facilitates abstract discriminations and descriptions, and helps to make possible a generalized conception of the process as a whole.

The consideration of such well-known principles of the philosophy of science would be quite out of place were it not for the teleological implications of the conclusion. The peculiarities of the elements appear to be original characteristics of the universe, or if not they at least appear to arise invariably and universally when conditions make possible the stability of the atoms. Nothing is more certain than that the properties of hydrogen, carbon, and oxygen are changeless throughout time and space. It is conceivable that the atoms may be formed and that they may decay. But while they exist they are uniform, or at least they possess perfect statistical uniformity which leads to absolute constancy of all their sensible characteristics, that is to say of all the properties with which we are concerned. And yet this original characteristic of things is the principle cause of diversity in that stage of the evolutionary process which is fully within the grasp of natural science.

But it may be objected that in the strict scientific sense this is not a relation of cause and effect at all. For we are concerned with an indefinite number of chains of causation in each of which the preceding condition is at every point the cause of the succeeding condition.

Like Newton's law, or any other principle of science, great or small, the peculiarities of the three elements are, of course, the cause of nothing. They are merely the conditions under which the phenomena reveal themselves. And the world is now what it is because it was something else just a moment ago. There can be no objection to this position. But if we are therefore required to close our inquiry at this stage, the reply must be made that we shall then be obliged to exclude all the laws of science from our philosophy.

And so we may return to the conclusion that the principal peculiarity of the universe which makes diversity of evolution possible is original and anterior to all instances of the processes which it conditions. And we may recall the fact that this peculiarity consists of a group of characteristics such that they cannot be regarded as accidental. Finally, it will be remembered that the relations of this group of properties to the characteristics of systems are also such that they cannot be thought accidental. I believe that these statements are scientific facts. If this be so, we have arrived at the solution for a special case of Aristotle's problem of "the character of the material nature whose necessary results have been made available by rational nature for a final cause."[1]

Of course, objections will at once arise to the terms 'rational nature' and 'final cause.' In reply I have little to say, for I believe that Aristotle has justified his use, in his own day, of these terms. In the first place, I conceive that the term 'rational nature' of the fourth century may be translated into the modern term 'laws of nature.' For these laws are exclusively rational; they are the product of the human reason, and are not conceived by science to have objective existence in nature. This is also clearly true of the relation between the properties of the elements and the course of evolution. Secondly, as we have seen above, all phenomena are phenomena of systems. Hence the operations of a final cause, if such there be, can only occur through the evolution of systems. And therefore the greatest possible freedom for the evolution of systems involves the greatest possible freedom for the operation of a final cause.

[1] *De partibus animalium*, 663^b, 20.

The above statement may now be modified to the following effect: We possess a solution for a special case of the problem of the characteristics of the material nature whose necessary results have been made available by the laws of nature for any hypothetical final cause. Thus the whole problem of the teleological significance of our scientific conclusions reduces to the simple but infinitely difficult question whether a final cause is to be postulated.

Here we are once more confronted by the fact that no mechanical cause of the properties of the elements except an antecedent process is conceivable. And since the elements are uniform throughout space, there cannot have been, in the proper sense, any contingency about the operation of this cause. At the most, contingency can have only produced an irregular distribution of the different elements in different stars. But according to the orthodox scientific view there is no room for contingency in such discussions. Accordingly, the properties of the elements are to be regarded as fully determined and perfectly changeless in time. This we may take as a postulate. But the abstract characteristics of systems are no less fully determined and absolutely changeless in time. This is a second postulate.

Finally the *relation* between the numerous properties of hydrogen, carbon, and oxygen, severally and in coöperation, and the necessary conditions of existence of systems in respect of number, diversity and durability, as these conditions are defined by the exact analysis of Willard Gibbs, is certainly not due to chance. In other words, the statistical probability that this connection has a cause, is greater than the statistical probability which we can ever demand or usually realize in the establishment of our laws of science. It should be remembered that we are here dealing with three elements among more than eighty, and with more than twenty properties; further that it is not merely a question of the coincidence of the unique properties among the elements, but especially of the relation of these properties to systems. The uniqueness of the properties is significant only because it proves their unique fitness for systems. Finally, if it should be proved that the properties are the result of one simple cause, the question would become: What is the probability that from a single cause this group of unique fitnesses for a subsequent process should arise? This problem is mathematically identical with the earlier one.

No mechanical cause of the properties of the elements is, however, conceivable which should be mechanically dependent upon the characteristics of systems. For no mechanical cause whatever is conceivable of those original conditions, whatever they may be, which unequivocally determine the changeless properties of the elements and the general characteristics of systems alike. We are therefore led to the hypothesis that the properties of the three elements are somehow a preparation for the evolutionary process. Indeed this is the only explanation of the connection which is at present imaginable.

Such an hypothesis will have to be judged on its merits. Admitting the scientific facts, it possesses, so far as I can see, two defects. In the first place, the term preparation is scientifically unintelligible; secondly, this hypothesis is not only novel but it is different in kind from all other scientific hypotheses. For no other scientific hypothesis involves preparations other than those which originate in the animal mind. In short, we are face to face with the problem of design. Concerning the philosophical aspects of this question I have nothing new to say. It seems to me to be clearly established in the history of thought that when the problem arises the only safety consists in taking refuge in the vaguest possible term which can be employed. That term is teleology. I shall therefore modify the above statement and say that the connection between the properties of the three elements and the evolutionary process is teleological and non-mechanical.

Here it may be pointed out that biological organization consists in a teleological and non-mechanical *relationship* between mechanical things and processes. In both cases the relationship is rational and non-mechanical, the things related mechanical and non-rational. Or, in other words, the relation is an affair of the reflective judgment, the things related of the determinant judgment. It is the failure to understand this distinction which is at the bottom of most misunderstandings concerning teleological problems in biology. The understanding may be facilitated by noting that the periodic classification of the elements is also a rational and non-mechanical relationship.

If it still be asked whether this conclusion has any intelligible meaning, the answer must be affirmative. For the concept of organization is now in general scientific use. How then should it be thought strange to find in the inorganic world something slightly analogous to that which is clearly recognized in the organic. Indeed, no idea is older or more common than a belief or suspicion that somehow nature itself is a great imperfect organism. There is nothing to commend such a view to natural science, but it may well have a foundation in undefined realities vaguely perceived.

We thus reach the conclusion that in one of its most important aspects the teleological appearance of nature depends upon an unquestionable relationship between the original characteristics of the universe which, because it is merely a relationship and in no sense a mechanical connection, because it is unmodified by the evolutionary process and changeless in time, is to be described as teleological. The reason why it must be described as teleological is that there is no other way to describe it. It is teleological just as the periodic system is periodic. In other words, the appearance of harmonious unity in nature, which no man can escape, depends upon a genuine harmonious unity which is proved to exist among certain of the abstract characteristics of the universe. As a qualification of such abstract characteristics, contingency, the one concept opposed to harmonious unity of nature, finds no place. Thus the teleological character of nature is recognized through a connection, conceivable only as teleological, among the abstract characteristics of nature.

It must not be forgotten that there is here involved but a single instance of a teleological connection between the laws of nature. And though we can vaguely distinguish other teleological aspects of the principles of science, as in the tendency toward dynamic equilibrium, there seems to be at present no possibility of investigating the problem in a more general manner.

Yet this single result is sufficient greatly to strengthen a philosophical position at which many thoughtful men have arrived from the most varied experiences and diverse lines of thought. Charles Darwin has stated it as follows:

"Another source of conviction of the existence of God, connected with the reason, and not with the feelings, impresses me as having much more weight. This follows from the extreme difficulty, or rather impossibility, of conceiving the immense and wonderful universe, including man with his capacity of looking far backwards and far into futurity, as the result of blind chance or necessity. When thus reflecting I feel compelled to look to a First Cause having an intelligent mind in some degree analogous to that of man; and I deserve to be called a Theist. This conclusion was strong in my mind about the time, as far as I can remember, when I wrote 'The Origin of Species,' and it is since that time that it has very gradually, with many fluctuations, become weaker. But then arises the doubt, can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such general conclusions?"

"I cannot pretend to throw the least light upon such abstruse problems. The mystery of the beginnings of all things is insoluble by us; and I for one must be content to remain an Agnostic."[1]

Evidently Darwin's unmethodical considerations of the problem have developed from an original theological view to a vague theism, and from that to a hesitating denial of the possibility that any intelligible explanation of the teleology of nature can be found. But from teleology itself he cannot escape. Thus his position is identical with that of Hume and a long line of other thinkers. The tormenting riddle, eternal and inexplicable, is the existence, not of the universe, but of nature.

The whole history of thought does but prove the justice of this conclusion. We may progressively lay bare the order of nature and define it with the aid of the exact sciences; thus we may recognize it for what it is and see that it is teleological. But we shall never find the explanation of the riddle. Upon this subject clear ideas and close reasoning are no longer possible, for thought has arrived at one of its natural frontiers. Nothing more remains but to admit that the riddle surpasses us and to conclude that the contrast of mechanism with teleology is the very foundation of the order of nature, which must ever be regarded from two complementary points of view, as a vast assemblage of changing systems and as an harmonious unity of changeless laws and qualities.[1]

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[1] *Life and Letters of C. Darwin*, London, 1888, Vol. I, pp. 312–313.

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[1] Cf. Bosanquet, *The Principle of Individuality and Value*, London, 1912, p. 155.